Investigation of the Depth of Penetration of a Magnetic Field into a Large Super-Conductor, [redacted]

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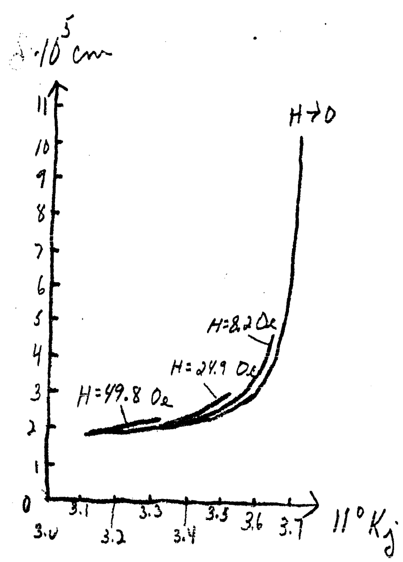
To the present time, only one experiment is known of investigating the depth of penetration of a magnetic field of a super-conductor of macroscopic size, which however was unsuccessful (Casimir [1]).



The intention of the experiment, is conducted by us, is to measure the change of electromotive force arising in a coil in which there is a super-condutive tin specimen, in the form of an ellipsoid 4 cm long and 1 cm in diameter. The specimen was in a constant magnetic field. Its temperature was modulated with a frequancy of 4 cycles/sec and lowered to the order of 0.01° with the aid of the compression and expansion of gaseous helium which filled the chamber including the coil ans sample. The variation in the depth of penetration due to the oscillations of the temperature led to variations in the magnetic current through the coil. The electromotive force arising in the coil was measured with the aid of a sensitive galvinometer with a photo-intensifier which was set for the frequency of the temperature oscillation. We were able to notice variations in the depth δ of penetration of the order of several angstroms and, consequently, to measure the derivative $\partial\delta / \partial T$, of the depth of penetration with respect to temperature, beginning from several millionths cm/deg. The specimen was prepared from tin, having no more than 0.002% of impurities. Its surface was carefully polished, after which the sample was annealed in a vacuum.

The measurements took place for various field intensities from 0.44 to 49.8 oersteds and the average temperature of the specimen varied from 3° K to the critical temperature. The derivative $\partial\delta / \partial T$, for small field intensities and temperatures, close to the critical, was governed by the asymptotic rule at $T \to T_c = 3.715°$ K It worked out well in the range 3.6° K to 3.704° K.

$$\left\{ \frac{\partial \delta}{\partial T} = \frac{5.4 \times 10^{-6}}{(3.715 - T)^{3/2}} \right.$$

From the data obtained, the absolute value of can be computed if we assume that $1/\delta^2$ can be expanded into a series of powers of $(T_c - T)$. Knowledge of the asymptotic rule for $\partial\delta / \partial T$ permits the determination of the constant of integration. The calculated values of δ for various field intensities H are included in the table below and in the diagram. In the calculations, it was assumed that the values of δ at rather low temperatures reached a constant value regardless of the field strength.

$T(^\circ K)$	$\delta \cdot 10^5$ (cm)			
	$H \to 0$	H=8.2 Oe	H=24.9 Oe	H=49.8 Oe
3.704	10.3			
3.70	8.8			
3.68	5.8			
3.65	4.24			
3.64	—	4.81		
3.60	3.19	3.63		
3.55	2.75	2.97		
3.52	—	—	3.08	
3.50	2.49	2.62	2.9	
3.47	2.4	—	—	
3.45	2.32	2.4	2.6	
3.40	2.2	2.25	2.34	
3.35	2.1	2.13	2.19	
3.325	—	—	—	2.31
3.30	2.03	2.05	2.08	2.26
3.25	1.98	1.99	2.0	2.14
3.20	1.93	1.93	1.95	2.04
3.15	1.9	1.9	1.9	1.95
3.10	1.87	1.87	1.87	1.89

A detailed account of our work will be published soon.

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Bibliography

(1) Casimir, H.B.G., - Physics, 4,887, 1940